The Role of Gesture Meaningfulness in Word Learning Across Genders

Undergraduate Research Thesis

Presented in Partial Fulfillment of the Requirements for graduation
"With Research Distinction in Psychology" in the undergraduate colleges of
The Ohio State University

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April 2013

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Abstract

The focus of this study is adult word learning through the use of gestures. Previous research has shown that children use word and gesture combinations during word learning and that meaningful gestures, when paired with the object name being learned, facilitate greater word learning. Participants were measured on their word learning through three gesture conditions: meaningful gesture, nonsense gesture, and no gesture. Analyses also focused on learning outcomes of nouns versus verbs, as well as high frequency versus low frequency words. A secondary study was conducted to address possible limitations of the primary study. Neither study found a significant difference in either gender or word class. Across both studies, meaningful gestures led to higher word learning than nonsense or no gestures, and high frequency words led to higher word learning than low frequency words for both nouns and verbs.

The Role of Gesture Meaningfulness in Word Learning across Genders

Gestures are a form of non-verbal communication that utilize visible body actions, either in place of speech or in combination with speech, to communicate a particular message. Gestures include physical movement of the hands, face, or other parts of the body (Kendon, 1982). Gestures are ubiquitous in human communication (Marshall, et al., 2012). Everybody knows what gesturing is (Obermeier, Dolk, & Gunter, 2011), and everyone has used some, and probably multiple forms of gesture throughout their lives. Children typically gesture before they use their first words, and girls, on average, tend to produce their first pointing gestures earlier than boys (Özçalişkan & Goldin-Meadow, 2010). In previous research conducted by Iverson and Goldin-Meadow (2005), they found that gesture both preceded and was highly correlated to language development. In an observational study of ten children between the ages of 10 and 24 months, they found that children relied exclusively on gesture to refer to objects half of the time, a quarter of the time they relied on both speech and gesture, and the remaining quarter relied on speech only. Gesture also became less important over time, and began to dissipate once the child learned the appropriate word. The findings support their hypothesis that gesture serves as a transitional device in early lexical development. However, it is not clear if gestures facilitate word learning after childhood.

Gender

Regardless of gesture use, there are often gender differences found in language. Language performance is generally better among females than among males, even in children as young as 2-3 years (Burman, Bitan, & Booth, 2008). This has been demonstrated in many observational studies with young children where females produce their first gesture, and consequently first words, prior to males, although the gender gap in regards to language becomes less prominent as

aging occurs. There has been much research conducted on how and why men and women acquire language differently. Communication style is one area that shows consistent gender differences (Cunningham, Carrico, & Pergram, 2004). Research shows that male language works to facilitate hierarchy and dominance; it is aggressive, competitive, and includes little intimacy. When men use gestures while speaking, they take up more space and make more powerful gestures, such as fist hitting hand. Female language works to facilitate interpersonal interactions; it is emotional, cooperative, and intimate (Cunningham et al., 2004). Women are better at reading and interpreting gestures by utilizing gestures that mimic the speech they are listening to as a way of conveying comprehension. Women lean into the speaker more, nod in comprehension more often, and repeat what they have been told more frequently.

Iconicity

Meaningful or iconic gestures, such as those used in American Sign Language, may benefit word learners if paired with a new word. Iconic gestures gain their communicative strength from being perceptually similar to the object or event that is being referred to (Roth, 2001). Sign language tends to encode more iconic form-meaning mappings than does spoken language. Using speech alone limits the body of iconicity in speech. When iconic gestures accompany speech, representations are encoded and help link speech to meaning (Thompson, Vinson, Woll, & Vigliocco, 2012). Iconicity in spoken language becomes more visible if you also consider the gestural and prosodic pieces that accompany speech. When a mother says using child directed speech, "That fish is huge," and extends her arms, iconic representation encoded in prosody and co-speech gesture may aid in linking speech to meaning, as in this example, the word "huge" (Thompson et al., 2012).

Children use iconic or meaningful gestures to convey relational information as early as 10 months (Özçalişkan & Goldin-Meadow, 2005), and this continues to develop into childhood. An example of a meaningful gesture at this age would be to point at an object that they desire, or waving bye-bye. In previous research by Cameron and Xu (2011), children age 6-7 were asked to retell a story and were either allowed to use gestures or required to keep their hands still. Children in the gesturing condition recalled far more details of the story than children in the non-gesturing condition. The use of gesture is not restricted to aiding spoken language communication. In a study by Thompson et al. (2012), parental report on the Communicative Development Inventory (CDI) adapted for British Sign Language (BSL), measured the number of words understood and produced by children between the ages of 8 and 30 months, using 89 signs. Analyses examined effects of iconicity in parental reports of the BSL. The results show that iconicity facilitates sign learning from early development and predicts early sign comprehension.

Gesture

Gestures aid comprehension and are beneficial for memory recall (So, Chen-Hui, & Wei-Shan, 2012). In a previous study, adults were asked to watch videos of a speaker listing off verbs either with gestures or without. Individuals remembered more words that were accompanied by gestures (Riseborough, 1981). However, much of the previous research to date has focused only on meaningful or iconic gestures. One exception to this is a study conducted by So et al., (2012). Children between the ages of 4-5 and adult participants were asked to watch video clips of a speaker reciting lists of verbs accompanied by either meaningful gesture, beat gesture (rhythmically moving the hand to match the prosody of speech), or no gesture. Each participant was tested after each condition for word recall. The results for both adults and children showed

that more words were recalled when they were encoded with iconic gestures than when encoding words alone. The beat gesture condition increased word learning for adults only compared with no gesture at all. Beat gestures may enhance memory recall in two ways: by bringing the listener's attention to parts of speech or by enhancing auditory processing of speech (So et al., 2012). Beat gestures were more helpful in word learning because encoding the beat along with the word increased language learning. However, it was not clear if adults' word learning in the beat gesture condition was due to the prosodic movements or if any movement would increase attention and therefore improve word learning. The current research aims to disentangle this. In previous research conducted by Goodrich and Hudson Kam (2009), they set out to determine if participants could learn the meanings of a new verb through the aid of iconic gestures when no other informational cues were available. Across four age groups; 2, 3, and four year olds, and adults, were asked to learn four verbs that described actions of novel toys. The presenters would show the participants a toy and ask, "Which toy let's Sam go (*novel verb*)-ing?" while demonstrating the gesture. Participants responded by indicating their selection. These trials were presented in an iconic gesture, other gesture (another term for nonsense gesture), or no gesture condition. The results showed that children and adults can use iconic gestures to determine the meaning of a novel verb, but it was inconclusive if the participants were mapping the novel verb to the action performed by the toy, or simply paying attention to the gesture.

Word Frequency and Word Class

High frequency words create additional different associations than do low frequency words, and should be linked more readily by lexical chains (Postman, 1970). A lexical chain is a series of words, spanning either a short or long distance, that upon repeated exposure provide a context for identification of the word being presented. Repeated exposure to the high frequency

words provide additional memory mappings that aid in the recall of these words. Even when recall is varied over long range, the differences in word recall are small (Postman, 1970). In a previous study by Postman (1970) on word frequency and recall, higher frequency words were learned faster than medium and low frequency words.

In addition, children learn verbs more slowly than nouns. The meanings of nouns are more concrete and can be demonstrated simply by pointing to objects. Verbs express relational meaning and depend on abstract concepts (Gentner, 1978). In a study by Goldin-Meadow et al., (1976) twelve children ages 14 to26 months were tested on their knowledge of nouns and verbs using a vocabulary comprehension and a vocabulary production test. Comprehension questions for nouns and verbs were randomly asked throughout the sessions, with one experimenter asking the vocabulary questions and the other recording the child's utterances and nonverbal contexts. There were a total of 70 nouns and 30 verbs presented at least twice to each child. Each word was presented once in the comprehension test and once in the production test. They found that the children produced more nouns than verbs. This is attributed to the fundamental differences between nouns and verbs in that we can point to a noun, but there is no obvious referent for a verb. In previous research it has been shown that verbs are harder to remember, have broader definitions, are prone to adjustments in meaning when there is a conflict of meaning, and are less stable in translation across languages than nouns (Goldin-Meadow et al., 1994). In contrast with nouns, the spoken production of a verb is not preceded first by the gesture. Gestures are produced before and predict the onset of a noun in children; gestures do not precede the onset of children's verbs, and instead children rely most on speech to convey early action meanings (Özçalişkan, Gentner, & Goldin-Meadow, 2013). For this reason, it is hypothesized that nouns will have higher learning outcomes than verbs.

In the current research, across two studies, meaningful gestures, nonsense gestures, and no gestures were utilized to explore the differences in language learning outcomes of men and women across different task difficulties and word classes. Meaningful gestures, another name for iconic gestures, are a form of nonverbal communication in which visible body actions provide a clear meaning of the word being conveyed. In direct opposition, nonsense gestures are a form of nonverbal communication in which visible body movements provide no meaning of words being conveyed. Nonsense gestures differ from the beat gestures utilized in the previous study in that nonsense gestures provide no prosodic or lexical aid in the learning of language. Nonsense words are any word with no determinable or acceptable meaning. In pairing nonsense words with meaningful gestures, adults should be able to learn the intended meaning of the nonsense word and outperform pairings with nonsense gestures or no gesture at all. In the current research, men and women were taught nonsense words while being presented with meaningful gesture, nonsense gesture, or no gesture.

It was hypothesized that women would outperform men in learning nonsense words. It is also important to test whether people benefit more from meaningful gestures based on the difficulty of the task. For example, people may interpret speech alone if the task is easy, but may look more towards gestural information on a difficult task. This is similar to children's developmental trajectory, in that children rely more heavily on gestures until they gain a firm grasp of the word they are learning to use. Hearing a word more times, having more exposure to the word/gesture combination, should make the task easier. Therefore, high versus low frequency words were utilized to test for this benefit in the meaningful, nonsense, and no gesture conditions as a secondary variable. In addition to the previous research, which primarily has only investigated verb learning in connection to gestures, the learning of nouns will also be

assessed. Children's first words are primarily nouns. They are different from, and are conceptually more basic than the concepts referred to by verbs (Kuczaj, 1982). This being said, nouns should be more easily learned and identified than verbs in both men and women during this language learning task, and learning of nouns should have less reliance on gestures. However, it is not clear whether meaningfulness of gestures would benefit word learning differently across these two classes of words.

Study 1 investigates language learning through use of three gesture conditions: meaningful, nonsense, and no gestures. In addition to manipulating iconicity of gestures, utilization of these three gesture conditions facilitates the comparison of language learning outcomes between men and women, as well as the language learning outcomes of nouns versus verbs, and high frequency versus low frequency words.

Study 1: Easy Task

Method

Participants. There were a total of 106 participants from a population of Introductory Psychology students at a regional campus of a large Midwestern University. Of these participants, 54 were male and 52 were female. There were approximately an equal number of participants in each condition: meaningful gesture, nonsense gesture, and no gesture.

Only 5% of participants reported taking ASL for their foreign language requirement. Twelve percent of participants reported that English was not their primary language.

Design. The between subjects design was broken down into three conditions: meaningful gesture, nonsense gesture, and no gesture. Males and females in each condition were tested for learning accuracy of the preselected nonsense words. There are two secondary within subjects independent variables that were manipulated including word class (nouns versus verbs) and

frequency of exposure (high frequency versus low frequency). The participant's word learning across these conditions was assessed as the dependent variable.

Materials. Ten nouns and ten verbs were selected for use in the study from common one and two syllable words. A random number generator was used to select which words were to be used as high frequency and which were to be used as low frequency. Each regular English word was then paired with a nonsense word (See Appendix A). Once the words were selected and paired, ten sentences for each high frequency word and five sentences for each low frequency word were created. This made a total of 150 sentences (See Appendix B).

Next, American Sign Language (ASL) signs were used to provide the accompanying gestures. All of the gestures used for the meaningful condition were exact ASL signs and have a direct iconic connection with the word they were describing. The gestures selected for the nonsense gesture condition were ASL signs for different words that have no direct connection or shared meaning with the words they are describing. The selected nonsense gesture signs were ASL signs for words not used in this study, and were so obscure that the participants would have needed a strong knowledge of ASL to know what they meant. These signs were selected such that there would be no way of deciphering the intended meaning just by observing the sign itself. For example, the nonsense word for car is "*mot*", so mot would be paired with the ASL sign for car, which is holding both fists out in front of the chest and rotating them half turns, as if using a steering wheel. *Mot* would also be paired with the ASL sign for twist to create a nonsense gesture, which would provide no meaning of the word being conveyed. See examples in Figure 1. Once all of the English words were paired with nonsense words and ASL gestures, the order in which the sentences were presented was randomly selected using a random number generator.

The video clips were prerecorded using a digital video recorder, one video clip for each sentence and in each condition. There were 150 video clips per condition for a total of 450 video clips. Each video clip shows the female presenter from the waist up against a white backdrop speaking the nonsense word sentence while performing either the meaningful gesture, nonsense gesture, or no gesture depending on the condition. Each video clip ran for approximately 5 seconds. There is a one second lag at the end of each video clip from the time the last word of the sentence is said to the time the clip is ended. This is to ensure that there is the same amount of time between each sentence being heard and each video clip being presented. Each clip was shown utilizing a PowerPoint presentation on a desktop PC for visual stimulus, and each participant wore Kensington Hi-fi headphones to hear the auditory component.

At the end of the study, participants were asked to answer a 20 question multiple choice form to assess their word learning (See Appendix C). Participants were asked what each of the 20 nonsense words meant. For example, the participant heard "What does *mot* mean?" Each of the 20 prerecorded questions was read orally to the participant who was instructed not to answer the question until it had been read to them. The questions were asked to the participant in the same voice that it was initially presented to them on the video clips. The audio for the post test was a continuous recording that allowed 5 seconds between each question for the participant to answer. The participants answered by selecting from four choices given on the multiple choice questionnaire. The audio for the multiple choice portion, which assessed word learning, ran for exactly 4 minutes and 8 seconds before moving to the end of the presentation.

Before completion of the study, participants were required to fill out a demographics questionnaire (See Appendix D). The demographics questionnaire was used to assess age, ethnicity, gender, and class standing: freshman, sophomore, etc. Familiarity with American Sign

Language (ASL) was also assessed. Participants were asked specifically if they were currently taking, or had taken ASL to satisfy their foreign language requirements, and what their level of exposure to ASL had been. This was measured using a self-report scale from 1 to 5, with 1 being very familiar and 5 being not familiar at all. In addition to this information, participants were asked to report if English was their primary language, and if not, what their primary language was. The final question of the demographics asked if the participant knew what the purpose of the study was, and if so, to give a brief explanation.

Pilot Study. The meaningfulness of the gestures were tested in a pilot study to determine that the meaningful gestures were indeed more meaningful than the nonsense gestures. Twenty-eight pilot participants, chosen from the same participant pool as the main study, watched the 150 video clips, from either the meaningful or nonsense gesture condition. In these video clips, the presenter spoke each nonsense word while performing the appropriate gesture for the condition. These participants were asked to write what they thought each nonsense word meant while they watched and listened to the PowerPoint presentation. To account for this difference in design, the time allotted between each slide was increased to 7 seconds to allow participants time to write a response.

To measure the level of meaning for each gesture response, each of the 150 words was given a score between 0 and 3. A score of 0 was given for a completely incorrect report of the word. A score of 1 was given if the word reported was incorrect but made sense only in that particular sentence, meaning it could not be a plausible answer for any of the other sentences containing that word. A score of 2 was given if the word reported was a plausible answer and could be used in some of the sentences containing that word, but was not what was intended by the experimenter. A score of 3 was given if the participants reported the correct answer. A

higher score indicates that the word was more meaningful. Using this data, averages were calculated in three ways: the first time the gestures were presented with the word, the average of every time they heard the word, and the last time they were presented with the word. These averages of the mean for all exposures showed that the meaningful gestures (M = 2.97, SD = .01) were in fact more meaningful compared to the nonsense gestures (M = 2.01, SD = .09), t (38) = 50.03, $p < .001$ (See Figure 2).

Procedure. Each participant was tested in a group of no more than four, and watched a 30 minute Power Point presentation of 150 video clips appropriate for their gesture condition (meaningful, nonsense, or no gesture). Participants first saw a welcome slide followed by an instruction slide before the clips began so that the participant was able to start the presentation when they were fully ready. On the instruction slide, participants were told that they would be watching a video presentation followed by a brief questionnaire based on the video clips they had just seen. Participants were told that the entire study would last no more than 30 minutes. Once the video clips began, they ran continuously through the first 75 before showing a slide that indicated that the participant was halfway through the presentation. This slide required that the participant press the spacebar to continue the presentation. The presentation ran with a 5 second interval between each video clip. This was timed by Power Point. Word learning was assessed using the 20 point multiple choice questionnaire. Following the post test, participants were instructed to complete a demographics form and press the spacebar to continue. Once they had completed the demographics, participants were debriefed.

Results & Discussion

For each participant, an overall accuracy score was calculated by adding the number of correct responses, dividing by 20, the total number of words presented, and multiplying by 100

to get a percentage. Accuracy scores were then calculated in the same way for each of the other variables: noun, verb, high, and low frequencies.

Preliminary analysis indicated that there were no significant effects or interactions found for the word class (nouns vs. verbs) variable, $p > .05$, so this variable has been removed from further analysis. The primary analysis yielded the same results whether or not ASL and ESL participants were included, so all reported analyses include these participants. None of the participants provided a correct response to the purpose of the study, and no further analysis was conducted on this variable.

A 3 (Gesture condition: meaningful, nonsense, no gesture) x 2 (Gender) ANOVA on word learning accuracy, found there was a significant effect of condition, F (3, 104) = 17.91, $p < .05$, $\eta_p^2 = .28$ (See Figure 3). As predicted, LSD post hoc analyses found a significant difference in the meaningful gesture condition (M = 93.03%, SD = 6.48) over the nonsense (M = 71.62,% SD = 19.93), and no gesture conditions (M = 77.20%, SD = 15.53), *p's* < .05, indicating that meaningful gestures led to higher levels of accurate word learning over the other two conditions. The nonsense and no gesture conditions did not differ, $p > .05$. There were no significant main effects or interactions found with the gender variable, *p's* > .05, indicating males (M = 78.96%, SD = 18.40) and females (M = 81.56%, SD = 16.89) performed similarly across conditions.

Using a 3 (Gesture condition: meaningful, nonsense, no gesture) x 2 (Frequency: high vs. low) repeated measures ANOVA, there was a significant effect of frequency, F (1, 98) = 40.01, $p < .001$, $\eta_p^2 = .29$ (See Figure 4). As predicted, words presented in the high frequency condition (M = 85.00%, SD = 19.31) were more accurately learned than words presented in the low frequency condition (M = 75.48%, SD = 19.30).

It was speculated that the number of presentations of each stimuli shown may have made the task too easy, producing a ceiling effect, such that gender difference were not possible. Therefore, a second study was conducted in which the number of stimuli presentations was decreased, in the hopes that a gender difference would be revealed in a more difficult task.

Study 2: Difficult Task

Method

Participants. There were a total of 70 participants from a population of Introductory Psychology students at a regional campus of a large Midwestern University. Of these participants, 35 were male and 35 were female. There were an approximately equal number of participants in each condition: meaningful gesture, nonsense gesture, and no gesture. Seven percent of participants reported taking ASL for their foreign language requirement. Ten percent of participants reported that English was not their primary language.

Design. The between subjects design was broken down into three conditions: meaningful gesture, nonsense gesture, and no gesture. Males and females in each condition were tested for learning accuracy of the preselected nonsense words. There were two secondary within subjects independent variables that were manipulated including word class (nouns versus verbs) and frequency of exposure (high frequency versus low frequency). The participant's word learning across these conditions was assessed as the dependent variable.

Materials. The same ten nouns and ten verbs were selected for use in this study as were used in Study 1. The words selected for use as high frequency and low frequency remained the same from Study 1. The same nonsense words were used for this study as were used in Study 1, and a portion of the exact same sentences were used. For this study, only five sentences were presented for each high frequency word (instead of ten from the previous study) and two

sentences were presented for each low frequency words (instead of five). This made a total of 70 sentences (marked with an asterisk in Appendix B). The same American Sign Language signs from Study 1 were used to provide the accompanying gestures. Again, the order in which the sentences were presented was randomly selected using a random number generator.

To present the stimuli, a subset of the prerecorded video clips was taken from the previous study. There were 70 video clips per condition for a total of 210 video clips. Each video clip shows the female presenter from the waist up against a white backdrop speaking the nonsense word sentence while performing either the meaningful gesture, nonsense gesture, or no gesture depending on the condition. The video clips ran for approximately 5 seconds. There is a one second lag on the end of each video clip from the time the last word of the sentence is said to the time the clip is ended. This is to ensure that there is the same amount of time between each sentence being heard and each video clip being presented. Each clip was shown utilizing a PowerPoint presentation on a desktop PC for visual stimulus, and each participant wore Kensington Hi-fi headphones for the auditory component.

A demographics form was used to assess age, ethnicity, gender, and class standing: freshman, sophomore, etc. Familiarity to American Sign Language (ASL) was assessed. Participants were asked specifically if they were currently taking, or had taken ASL to satisfy their foreign language requirements, and what their level of exposure to ASL had been. This was measured using a self-report scale from 1 to 5, with 1 being very familiar and 5 being not familiar at all. In addition to this information, participants were asked to report if English was their primary language, and if not what their primary language was. The final question of the demographics asked if the participant knew what the purpose of the study was, and if so to give a brief explanation.

Procedure. Each participant was tested in a group of no more than four, and watched a 20 minute Power Point presentation of 70 video clips appropriate for their gesture condition (meaningful, nonsense, or no gesture). Participants first saw a welcome slide followed by an instruction slide before the clips began so that the participant began the presentation when they were fully ready. On the instruction slide, participants were told that they would be watching a video presentation followed by a brief questionnaire based on the video clips they had just seen. Participants were told that the entire study will take no more than 30 minutes. Once the video clips began, they ran continuously through the first 35 before showing a slide that indicated that the participant was halfway through the presentation. This slide required that the participant press the spacebar to continue the presentation. The presentation ran with a 5 second interval between each video clip. This was timed by Power Point.

At the end of the presentation, participants were asked to answer the same 20 question multiple choice form as was used in Study 1 to assess their word learning. For example, the participant heard "What does *mot* mean?" Each of the 20 prerecorded questions was read orally to the participant who was instructed not to answer the question until it had been read to them. The questions were asked to the participant in the same voice that it was initially presented to them on the video clips. The audio for the post test was a continuous recording that allowed 5 seconds between each question for the participant to answer. The participants answered by selecting from four choices given on the multiple choice questionnaire. The audio ran for exactly 4 minutes and 8 seconds before moving to the end of the presentation. Before completion of the study, participants were required to fill out the same demographics questionnaire that was used in Study 1.

Results & Discussion

For each participant, an overall accuracy score was calculated by adding the number of correct responses, dividing by 20 (the total number of words presented) and multiplying by 100 to get a percentage. Accuracy scores were then calculated in the same way for each of the other variables: noun, verb, high, and low frequencies.

Once again, preliminary analysis indicated that there were no significant effects or interactions found for the word class (nouns vs. verbs) variable, $p > .05$, so this variable was removed from further analysis. The primary analysis yielded the same results whether or not ASL and ESL participants were included, so all reported analyses include these participants. None of the participants provided a correct response to the purpose of the study, and no further analysis was conducted on this variable.

A 3 (Gesture condition: meaningful, nonsense, no gesture) x 2 (Gender) ANOVA found there was a significant effect of condition, F (2, 64), $p < .01$, $\eta_p^2 = .50$ (See Figure 5). LSD post hoc analyses found a significant difference in the meaningful gesture condition (M =91.25% , SD =7.86) over the nonsense (M =54.64% , SD =22.83) and no gesture conditions (M =55.22% , SD =25.81), p*'s* < .05, indicating that meaningful gestures led to higher levels of accurate word learning over the other two conditions. Study 2 confirms no significant main effect or interactions found with the gender (male vs. female) variable, $p > .05$, again indicating that males (M = 64.28%, SD = 25.12) and females (M = 66.28%, SD = 25.24) performed similarly across conditions.

Using a 3 (Gesture condition: meaningful, nonsense, no gesture) x 2 (Frequency: high vs. low) repeated measures ANOVA, there was a significant effect of frequency, F (1, 34) = 24.32, $p < .01$, $\eta_p^2 = .28$ (See Figure 6). As predicted, words presented in the high frequency condition

(*M* = 73.14%, *SD* =24.94) were more accurately learned than words presented in the low frequency condition (*M* =57.43%, *SD* =25.18).

General Discussion

Consistent with previous research, meaningful gestures provided greater language learning outcomes than nonsense or no gestures. In each previous study examined, meaningful gestures either aided in lexical development or facilitated greater language learning outcomes. Finding a significant effect of frequency, with high frequency words leading to greater language learning than low frequency words, also is supported by previous research. After evaluation of these results, it is suggested that the increased adult word learning demonstrated in the So, et al., (2012) study were due to the additional prosodic information gained from the beat gestures, and not merely from hand movement increasing attention to the task. These results, however, indicate that the meaningfulness of the hand movements added additional information and increased word learning in adults. It would appear that the lack of meaning in the nonsense gesture condition hindered word learning abilities in this study, as opposed to the beat gestures used in the So, et al., (2012) study, where word learning was increased. Non-iconic gestures demonstrated decreased word learning in both the So et al, (2012) study as well as in the Goodrich and Hudson Kam (2009) study, indicating that participants are looking to the gesture for cues in language learning, and that providing false information is more harmful than no information at all. Further analyses incorporating all four: meaningful, nonsense, beat, and no gesture conditions would need to be conducted in order to comprehensively deconstruct the effect.

Meaningful gestures are not just an ancillary feature of language, but are central features of communication (Roth, 2001). Although this research found no statistically significant gender

difference, this could be due in part to the increasingly narrower language gap with age (Feingold, 1988). Girls have an advantage over boys in verbal fluency, spelling, and grammar throughout the school years. Although this advantage is present, and girls have greater vocabularies and read better than boys, the female vocabulary advantage is gone by the age of 10 (Feingold, 1993). Gender differences and use of gestures in language comprehension is an area that has not had much research conducted to this point.

By exploring the subject of gestures, we can improve upon the ways people communicate with one another. Hearing problems are reported in as many as 30% of people aged 75-84 years; these percentages rapidly increase from this point on, with as many as 54% of the elderly reporting hearing problems by the age of 85 years (Solheim, Kvaerner & Falkenberg, 2011). The increasing lifespan in our population will result in an increased number of elderly people who suffer from hearing related problems (Solheim, et al., 2011). Older adults report difficulties understanding spoken language, with fast speaking rate and background noise being indicated as main interferences (Haubert & Fuller-Pichora, 1999). When older adults are strained due to loss of sensory capacity, the negative effects on sentence comprehension can be further multiplied (Stewart & Wingfield, 2009). Finding a use for gestures as an aid in communication and further exploring whether gender differences in gesturing exist in the older community, is one arena where this research could be furthered. It may also be of interest, while conducting this study with older adults, to note any language retention differences between men and women in late adulthood.

Gender difference in cognitive abilities across adulthood is an area where research has been plentiful but some areas remain inconclusive (Maitland, Intrieri, Schaie & Willis, 2000). A meta-analysis of 25 studies support that women maintain superior verbal episodic memory and

verbal fluency through adulthood. While conducting a five-factor measurement of cognitive abilities, older participants declined on all latent cognitive factors, except verbal comprehension in women (Maitland, et al., 2000). This suggests that perhaps these gender differences in gesture use may help protect women from a decline in their language abilities even when sensory capacities are beginning to fail. This potential protective factor of gesture use has yet to be explored.

Replication of this study in preschools and elementary schools may yield different results. Gestures may even play an important role in the emergence of language, even in high school students (Roth, 2001). Few studies exist that focus on gesture in an educational context. This research may be very important in helping to better understand the role of gestures in learning (Roth, 2001). It would be expected that a significant gender difference would be found in young children because there is a gender difference in language acquisition from an early age. Many studies show an early female advantage in language, and that girls consistently outperform boys in language tasks (Dabašinskienė, 2012). By utilizing this study with a focus on gender differences in gestural use, teaching could potentially be enhanced by expanding teaching styles to include gestures appropriate to gender. As previously reported by So, et al. (2012), children tended to remember information conveyed by their teachers when paired with gestures. Additionally, 8-year-old children instructed in both speech and gestures, compared to speech only, had better learning of math retention strategies after a month. Gestures may also be beneficial as an educational tool with children who have language learning delays.

In sum, there was a main effect of condition, with meaningful gestures having better word learning outcomes than nonsense or no gesture. This is consistent with previous research on the subject. The main effect of frequency is also consistent with previous studies, in that higher

frequency words have better learning outcomes than lower frequency words. In conclusion, meaningful gestures clearly aid language learning in adults. Although there was not a significant main effect of gender found across either study, this is just a beginning analysis of the subject. There are still many other ways that gender and gestures can be examined. Further research should extend this by incorporating beat gestures into the experiment. Beat gestures facilitate recall, serve meta-cognitive functions by marking or emphasizing the word, and by changing acoustic properties of speech (So, et al., 2012). Although the previous research did not focus on gender differences, this could be an additional level to incorporate and explore between genders. It is also important to note that this study clearly showed a benefit of gestures when learning nouns, not just verbs, as has been the focus of previous research. This study has shown that both nouns and verbs were similarly benefitted by the use of meaningful gestures.

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Appendix A: English/Nonsense Word Pairings, Word Class and Frequency

WORD CLASS	ENGLISH WORD	NONSENSE WORD	FREQUENCY
Verb	CUT	KEJ	HIGH
Verb	EAT	FIM	HIGH
Verb	SWIM	HOSH	LOW
Verb	SLEEP	JOM	HIGH
Verb	HEAR	CHEP	HIGH
Verb	CALL	TOB	HIGH
Verb	DRINK	PIM	LOW
Verb	BREAK	KOG	LOW
Verb	OPEN	NAF	LOW
Verb	WASH	CHIG	LOW
Noun	BABY	MACHRY	HIGH
Noun	BALL	VOVE	LOW
Noun	COAT	DAX	HIGH
Noun	MONEY	CROPPO	LOW
Noun	PIANO	AUTUNG	HIGH
Noun	TENT	CHIB	LOW
Noun	CAR	MOT	HIGH
Noun	CAMERA	PAGBO	LOW
Noun	BOOK	ZEK	HIGH
Noun	BIRD	FEP	LOW

Appendix B: Sentence Pairs with English and Nonsense Words.

English Sentence:	Nonsense sentence:
1. Call me when you get there.	*Tob* me when you get there. *
2. That book was short.	That *zek* was short. *
3. Put the money in the bank.	Put the *croppo* in the bank. *
4. She wrecked the car.	She wrecked the *mot*. *
5. Wait until you hear the beep	Wait until you *chep* the beep. *
6. How much sleep do you need?	How much *jom* do you need? *
7. Take the baby for a walk.	Take the *machry* for a walk. *
8. Open the door.	*Naf* the door. *
9. Do you have a coat?	Do you have a *dax*? *
10. Can you call him?	Can you *tob* him? *
11. We had to break the window.	We had to *kog* the window. *
12. The noise woke me from my sleep.	The noise woke me from my *jom*. *
13. She got her hair cut for school.	She got her hair *kej* for school. *
14. Don't cut your finger.	Don't *kej* your finger. *
15. Bounce the ball.	Bounce the *vove*. *
16. I got the book from the library.	I got the *zek* from the library. *
17. Don't sleep during class.	Don't *jom* during class. *
18. I can't hear you.	I can't *chep* you. *
19. You need to wear a coat in the winter.	You need to wear a *dax* in the winter. *
20. I have a pet bird.	I have a pet *fep*. *
21. He had a break in concentration.	He had a *kog* in concentration. *
22. Repeat exactly what you hear.	Repeat exactly what you *chep*. *

23. You should get more sleep	You should get more *jom*. *
24. The baby is cute.	The *machry* is cute. *
25. You should eat more fruit.	You should *fim* more fruit. *
26. You should call the doctor.	You should *tob* the doctor. *
27. Was there a call for me?	Was there a *tob* for me? *
28. The ball is red.	The *vove* is red. *
29. Pitch the tent in the yard.	Pitch the *chib* in the yard. *
30. Can you hear me?	Can you *chep* me? *
31. Where is the book?	Where is the *zek*? *
32. We traveled by car.	We traveled by *mot*. *
33. His car is blue.	His *mot* is blue. *
34. Beethoven played the piano.	Beethoven played the *autung*. *
35. Open the box.	*Naf* the box. *
36. I bought a new car.	I bought a new *mot*. *
37. Did you break your arm?	Did you *kog* your arm? *
38. That book was long.	That *zek* was long. *
39. The car needs oil.	The *mot* needs oil. *
40. Did you hear the phone ring?	Did you *chep* the phone ring? *
41. What do you hear?	What do you *chep*? *
42. She got a new camera for Christmas.	She got a new *pagbo* for Christmas. *
43. They made a movie of that book.	They made a movie of that *zek*. *
44. How long do you sleep?	How long do you *jom*? *
45. Put the book on the shelf.	Put the *zek* on the shelf. *

46. I need to make a call.	I need to make a *tob*. *
47. Read the book.	Read the *zek*. *
48. You could hear a pin drop.	You could *chep* a pin drop. *
49. We eat at noon.	We *fim* at noon. *
50. Clean the bird cage.	Clean the *fep* cage. *
51. The blue bird sang.	The blue *fep* sang. *
52. Do you know how to swim?	Do you know how to *hosh*? *
53. The circus was in a big tent.	The circus was in a big *chib*. *
54. It is time to feed the baby.	It is time to feed the *machry*. *
55. The piano is black.	The *autung* is black. *
56. The girl learned how to swim.	The girl learned how to *hosh*. *
57. Stop the car.	Stop the *mot*. *
58. Put the car in gear.	Put the *mot* in gear. *
59. Pick up the baby.	Pick up the *machry*. *
60. I made a lot of money.	I made a lot of *croppo*. *
61. The fir coat is soft.	The fir *dax* is soft. *
62. Fish can swim.	Fish can *hosh*. *
63. Put the clothes in the wash.	Put the clothes in the *chig*. *
64. Mice eat cheese.	Mice *fim* cheese. *
65. Bring the car around.	Bring the *mot* around. *
66. Wash the laundry.	*Chig* the laundry. *
67. He broke the camera when he dropped it.	He broke the *pagbo* when he dropped it. *
68. The camera needs film.	The *pagbo* needs film. *

69. Did you wash that dish?	Did you *chig* that dish? *
70. The wedding tent was beautiful.	The wedding *chib* was beautiful. *
71. Bring your ball to practice.	Bring your *vove* to practice.
72. Throw the ball to me.	Throw the *vove* to me.
73. We will call you with the results.	We will *tob* you with the results.
74. Hang up your coat.	Hang up your *dax*.
75. That book is funny.	That *zek* is funny.
76. His coat is reversible.	His *dax* is reversible.
77. Take the baby to daycare.	Take the *machry* to daycare.
78. Watch what you eat.	Watch what you *fim*.
79. Swim in the pool.	*Hosh* in the pool.
80. Did you change the baby?	Did you change the *machry*?
81. He cut the grass.	He *kej* the grass.
82. We cut the tree down.	We *kej* the tree down.
83. When is the best time to call?	When is the best time to *tob*?
84. Wash the window.	*Chig* the window.
85. Put your coat on.	Put your *dax* on.
86. I bought a grand piano.	I bought a grand *autung*.
87. Call a cab.	*Tob* a cab.
88. Warm milk will help you sleep.	Warm milk will help you *jom*.
89. Break the seal.	*Kog* the seal.
90. Eat what you want.	*Fim* what you want.
91. The boy cut the rope.	The boy *kej* the rope.

92. Did you read the book?	Did you read the *zek*?
93. Let's go for a swim.	Let's go for a *hosh*.
94. Take your coat off.	Take your *dax* off.
95. The boy went to sleep.	The boy went to *jom*.
96. Did you call her?	Did you *tob* her?
97. She cut the paper with the scissors.	She *kej* the paper with the scissors.
98. Everyone should eat breakfast.	Everyone should *fim* breakfast.
99. What time should I call you?	What time should I *tob* you?
100. I hear a siren.	I *chep* a siren.
101. Do you drean in your sleep?	Do you dream in your *jom*?
102. Do you use shampoo..wash your hair?	Do you use shampoo..*chig* your hair?
103. The piano has seven octaves.	The *autung* has seven octaves.
104. The paper was cut in squares.	The paper was *kej* in squares.
105. Hit the ball with the bat.	Hit the *vove* with the bat.
106. Watch the baby crawl.	Watch the *machry* crawl.
107. The bird built a nest.	The *fep* built a nest.
108. I lost my money.	I lost my *croppo*.
109. Please drink your juice.	Please *pim* your juice.
110. Her coat is warm.	Her *dax* is warm.
111. I can hear you.	I can *chep* you.
112. Should we drink the water?	Should we *pim* the water?
113. Look at the baby smile.	Look at the *machry* smile.
114. She played the piano.	She played the *autung*.

115. Give her the money.	Give her the *croppo*.
116. This is a two person piano piece.	This is a two person *autung* piece.
117. Drive the car to work.	Drive the *mot* to work.
118. You'll need stitches if you cut your finger.	You'll need stitches if you *kej* your finger.
119. Don't drink the milk.	Don't *pim* the milk.
120. Put the baby in the crib.	Put the *machry* in the crib.
121. The piano is the most popular instrument.	The *autung* is the most popular instrument.
122. Sing to the baby.	Sing to the *machry*.
123. Money is green.	*Croppo* is green.
124. The piano is a string instrument.	The *autung* is a string instrument.
125. The penguin is a bird.	The penguin is a *fep*.
126. Leave the door open.	Leave the door *naf*.
127. Tune the piano.	Tune the *autung*.
128. Take the camera on vacation with you.	Take the *pagbo* on vacation with you.
129. Eat your vegetables.	*Fim* your vegetables.
130. What time do you eat?	What time do you *fim*?
131. What time do you open?	What time do you *naf*?
132. Listen to the woman play the piano.	Listen to the woman play the *autung*.
133. After exercise..drink a lot of water.	After exercise..*pim* a lot of water.
134. Cut the steak.	*Kej* the steak.
135. Eat your food at the table.	*Fim* your food at the table.
136. You should not eat too much sugar.	You should not *fim* too much sugar.
137. Take a drink of water.	Take a *pim* of water.

138. They cut in line to get the best seats.	They *kej* in line to get the best seats.
139. The book is orange.	The *zek* is orange.
140. Can you open the window please?	Can you *naf* the window please?
141. He didn't sleep well last night.	He didn't *jom* well last night.
142. Put your coat on the rack.	Put your *dax* on the rack.
143. He did a sleep study..daytime fatigue.	He did a *jom* study..daytime fatigue.
144. We camped in a tent.	We camped in a *chib*.
145. The coat is grey.	The *dax* is grey.
146. I took his picture with my camera.	I took his picture with my *pagbo*.
147. Did you hear that?	Did you *chep* that?
148. We lost a pole to our tent.	We lost a pole to our *chib*.
149. Break into the bank.	*Kog* into the bank.
150. Put the car in the garage.	Put the *mot* in the garage.

* Indicates sentences that were used in Study 2.

Appendix C: 20 Question Post test with Answers

1.	A. Money	B. Milk	C. Shirt	D. Dough
2.	A. Scratch	B. Cut	C. Stab	D. Run
3.	A. Giant	B. Baby	C. Dog	D. Fairy
4.	A. Absorb	B. Swallow	C. Eat	D. Take
5.	A. Box	B. Hoop	C. Ball	D. Bat
6.	A. Run	B. Glide	C. Paddle	D. Swim
7.	A. Thread	B. Coat	C. Pant	D. Plate
8.	A. Run	B. Jump	C. Trance	D. Sleep
9.	A. Harp	B. Drum	C. Piano	D. Tarp
10.	A. Hear	B. Smell	C. Attend	D. Strain
11.	A. House	B. Tent	C. Canvas	D. Tree
12.	A. Call	B. Talk	C. Walk	D. Shout
13.	A. Bike	B. Door	C. Buggy	D. Car
14.	A. Drink	B. Toast	C. Walk	D. Splash
15.	A. Wink	B. Camera	C. Hat	D. Doll
16.	A. Break	B. Tear	C. Seal	D. Join
17.	A. Folder	B. Paper	C. Book	D. Copy
18.	A. Close	B. Open	C. Roll	D. Peel
19.	A. Mouse	B. Zebra	C. Fly	D. Bird
20.	A. Iron	B. Dirty	C. Wash	D. Stain

Appendix D: Participant Demographic Information

In order to determine whether the results of our study apply to the general population or only to a specific subset, we ask that you take a few minutes to complete the following information. This information is for descriptive purposes only and will remain strictly confidential. Please do not put your name on this form. We appreciate your help and your willingness to cooperate in our research. Thank you.

Age: ____ Sex: ___ Male___ Female

RACE/ETHNICITY (Check all that apply)
____ White
____ Black/ African-American
____ Hispanic
____ Asian/Pacific Islander
____ Native American
____ Middle Eastern
____ Multi-Racial
____ Other (Please specify
_____

MARITAL STATUS:
____ Single
____ Married
____ Divorced
____ Widowed
____ Separated
____ Other (Please explain)
_____

TYPE OF HOUSING:
____ Own house ____ Rent house ____Apartment Other:_____

EMPLOYMENT STATUS: (Mark all that apply)
____ Full-time ____Part-time ____Student ____Do not work outside of home
Other:_____

EDUCATION STATUS:
Year in College:_____ Major:_____ GPA:_____

Do you have normal or corrected to normal vision? ____YES ____NO

Is English your first language? ____YES ____NO
If no, what is your first language? _____

Have you taken or are you currently taking American Sign Language as your foreign language? ____YES ____NO

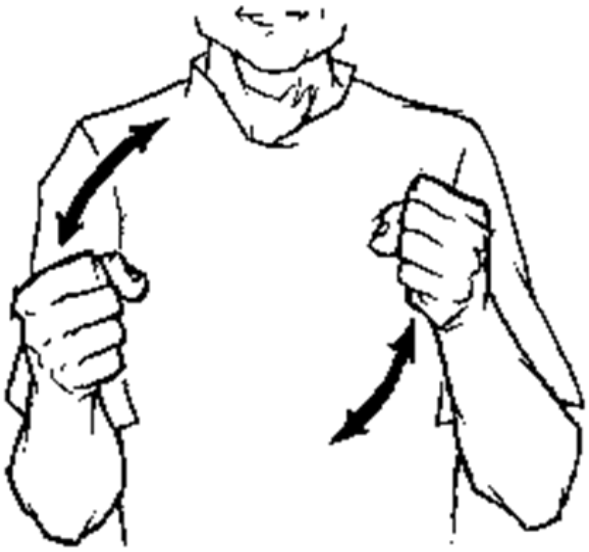
How often have you been exposed to American Sign Language?
____VERY FREQUENTLY
____FREQUENTLY
____OCCASIONALLY
____RARELY
____NEVER

Do you know the purpose of this study? ____YES ____NO

If YES please write the purpose of the study. _____

Figure 1. Gesture example

Meaningful gesture for the word car:



Nonsense gesture for the word car:

Figure 2. Pilot Data

Average correct response in Pilot Study across meaningful and nonsense gesture conditions. Bars represent standard error of the mean.

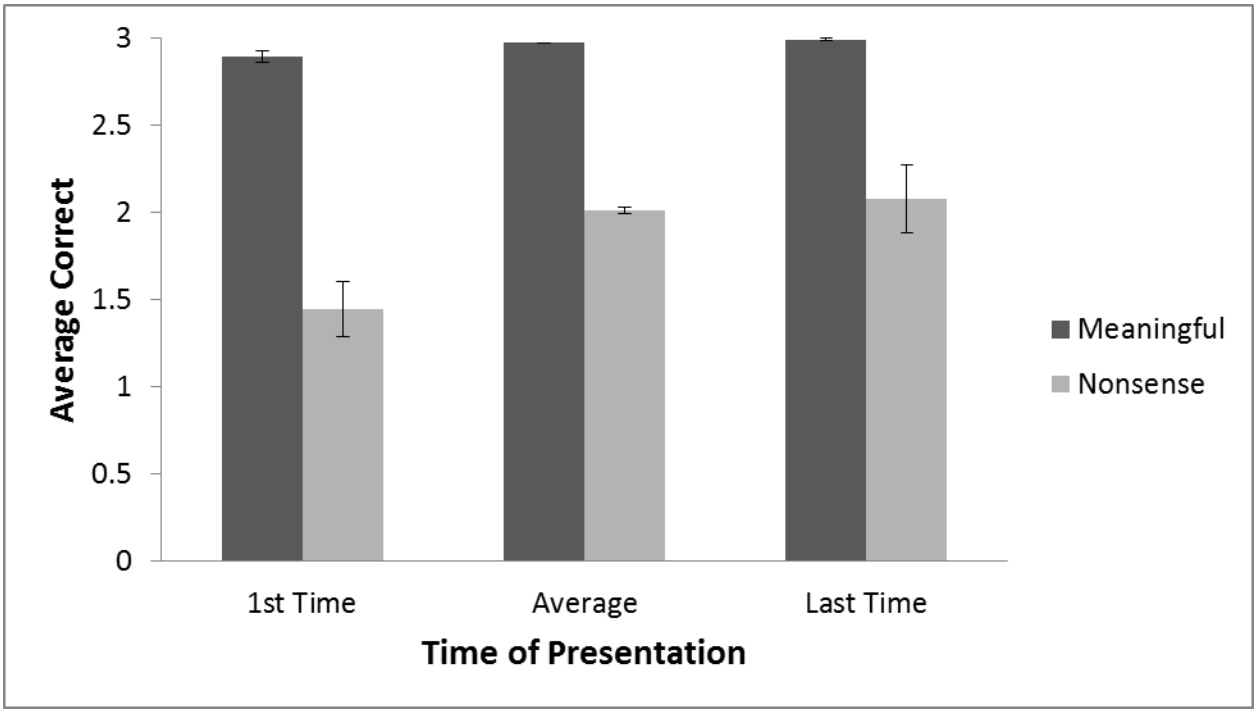


Figure 3. Significant effect of Condition/Study 1

Word learning accuracy across gesture condition in Study 1. Bars represent standard error of the mean.

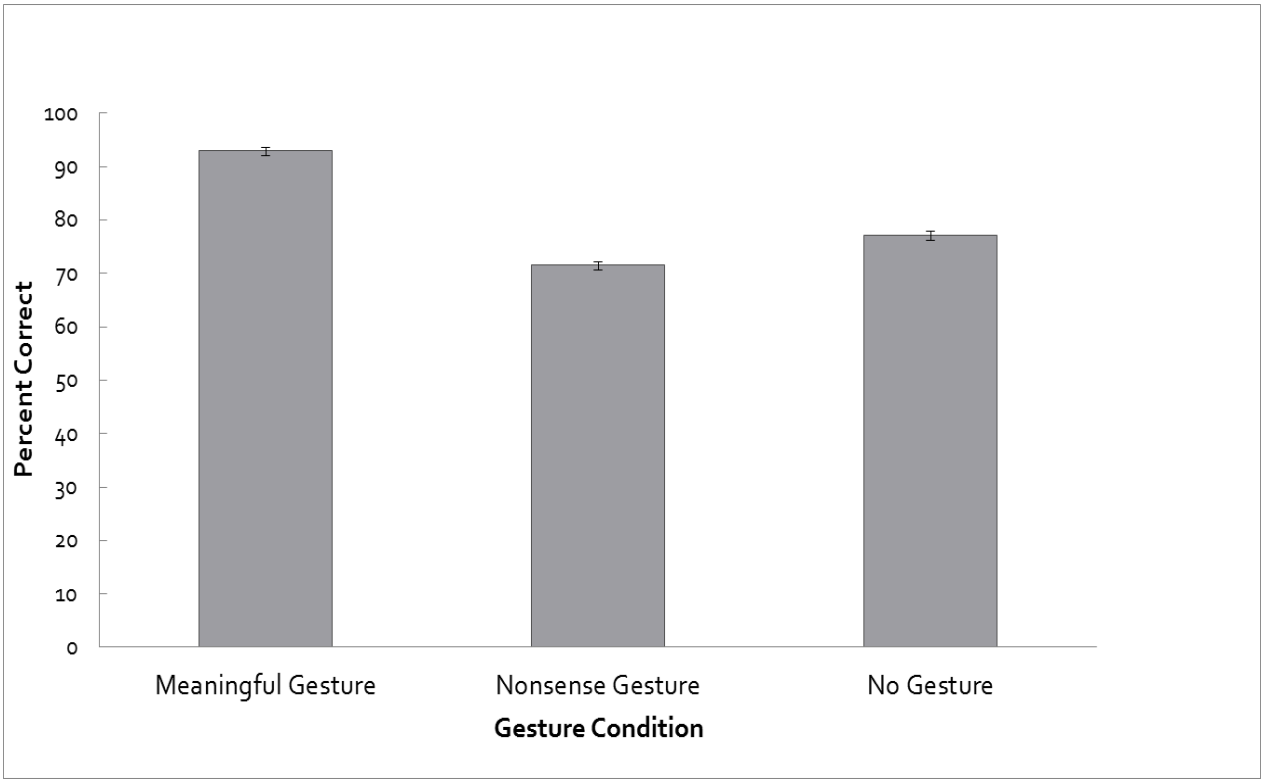


*Figure 4***.** Significant effect of Frequency/Study 1

Word learning accuracy across frequency of words in Study 1. Bars represent standard error of the mean.

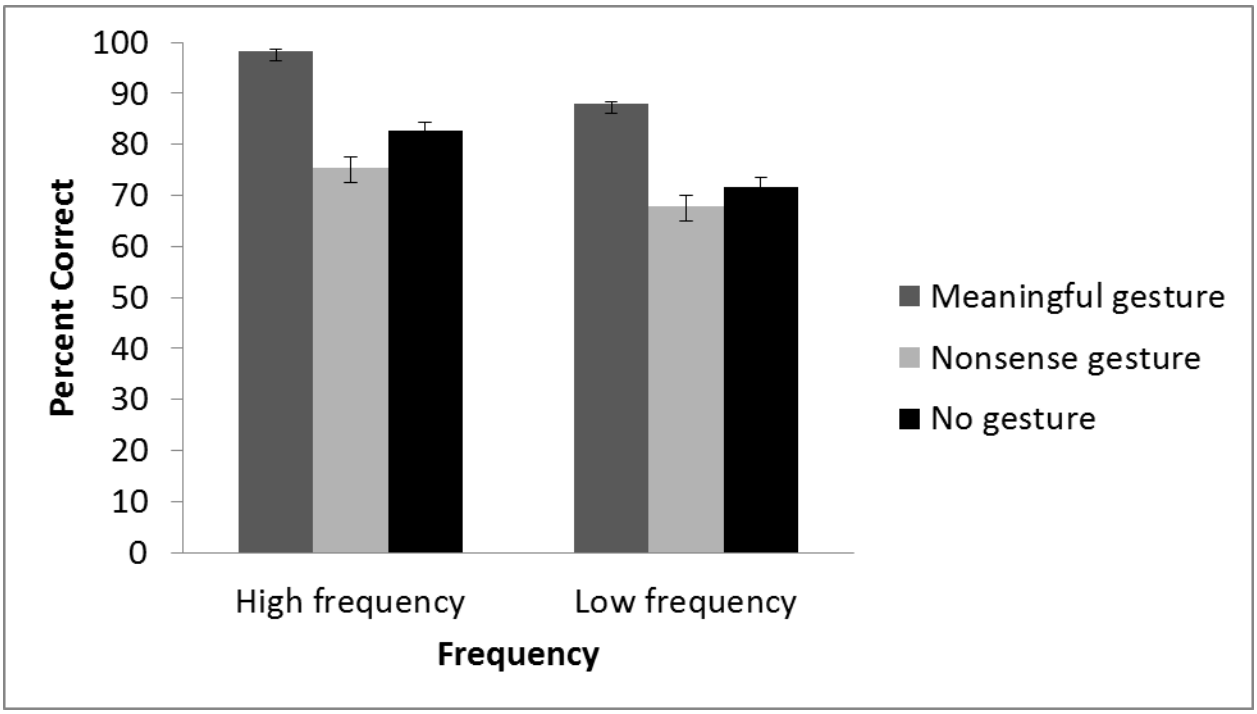


*Figure 5***.** Significant effect of Condition/Study 2

Word learning accuracy across gesture conditions in Study 2. Bars represent standard error of mean.

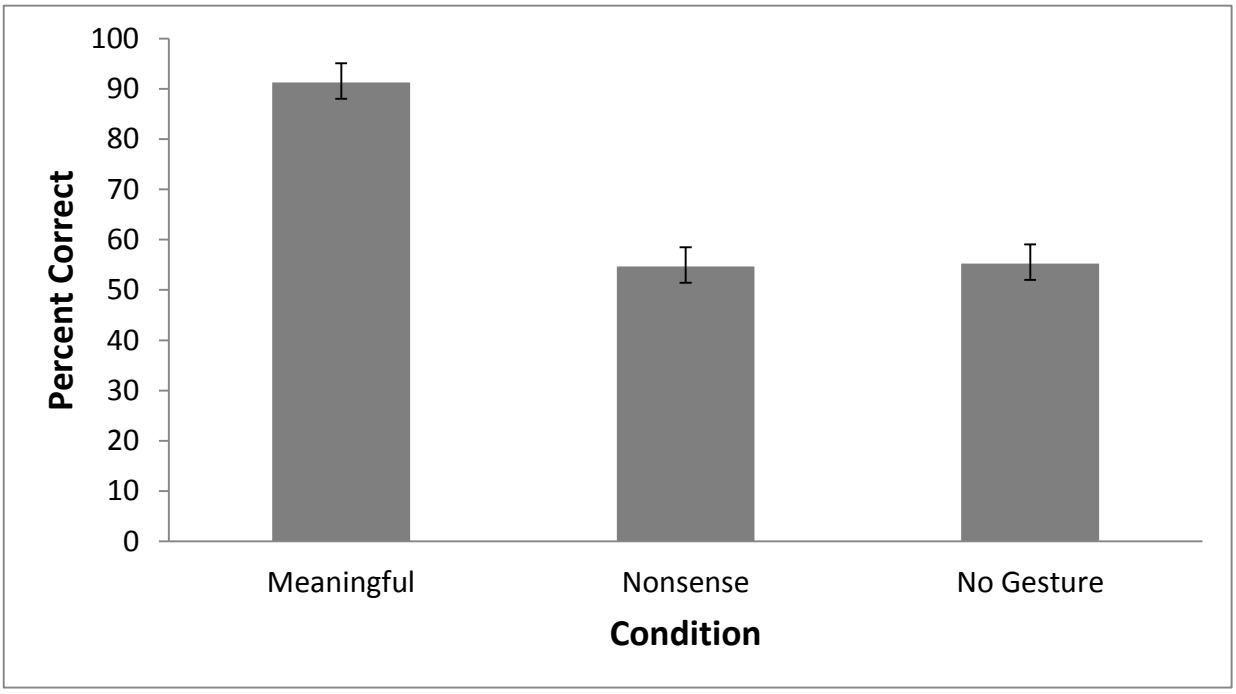


*Figure 6***.** Significant effect of Frequency/Study 2

Word learning accuracy across frequency of words in Study 2. Bars represent standard error of the mean.